Appendix B:
Stormwater Quality Computation Approaches and Profile Sheets

1. Introduction

This appendix takes a step back from the proposed regulations and considers the big picture objectives for developing a water quality computation approach. The main part of the appendix outlines five water quality computation methods, and provides examples and analysis for each method. Detailed profile sheets are provided for each of the five methods. An evaluation of these methods supports the proposed Nutrient Design System. The proposed system uses a combination of performance standards and a BMP technology approach.

2. Objectives for Developing a Water Quality Approach

There are various methods available to ascertain a site's water quality requirement. The selection of a particular method depends on the program's objectives. Possible program objectives include:

1. Site Compliance Tool: The method allows site designers and plan reviewers to have a common language about what is required for a particular site. The designer prepares and submits computations. The plan reviewer approves these to verify compliance with the standards in a stormwater ordinance or design manual. This is a very important objective for local stormwater programs.
2. Pollutant Accounting Tool: The method allows the program to measure and track pollutant loads and local reductions attributable to stormwater BMPs as land use changes take place. For instance, Virginia DCR needs to track progress towards reaching Tributary Strategy goals for urban land for a range of pollutants.
3. Site Design Tool: In some cases, the method becomes a *de facto* BMP selection process. This is largely due to the fact that, with some methods, compliance can only be achieved with certain BMPs, such as structural practices. If a program desires to incorporate better site design (BSD) and low-impact development (LID) approaches, the method must account for the use of these practices. One reason that BSD/LID is not more widespread is that traditional methods do not account for the range of practices involved (such as natural area conservation and impervious disconnection).
4. Offset Fee Tool: Some programs use an off-set fee or fee-in-lieu program for sites that cannot achieve full compliance with on-site BMPs. Usually, these fees are based on untreated pollutant loads computed for the site. In this regard, the method is used to compute appropriate off-set fees.

In the case of Virginia's proposed regulations, all four objectives have been considered. Offset fees may have a very limited role in the proposed state system, although programs that use such fees remain as a local option for more advanced programs.

3. Overview of Water Quality Methods

The following methods are available for a water quality compliance system. For the purposes of this analysis, each is assumed to use the Simple Method as the base computational method.

1. Existing CBLAD Method: The currently used method establishes 16% impervious as the "average land cover condition" for the Chesapeake Bay watershed in Virginia. Proposed development projects fall into one of four categories based pre-development and post-development impervious cover and the presence of existing BMPs. The method is detailed in Chapter 5 of the Virginia Stormwater Management Handbook.
2. Pollutant Load Performance Standard: The proposed regulations adopt this approach, whereby each site must meet a set load requirement. For instance, the proposed load requirement for total phosphorus is 0.28 pounds/acre/year. Each site must demonstrate that post-development loads do not exceed this limit, regardless of calculated pre and post-development loads.
3. Across-The-Board Removal Rate Standard: Other programs require a one-size-fits-all removal rate, such as 80% removal of post-development total suspended solids and 40% removal of post-development total phosphorus. Another example is the 10% reduction of pre-development loads used for redevelopment in Virginia and Maryland's Critical Areas.
4. No Net Increase Load Standard: This standard requires that post-development loads do not exceed the pre-development load. Pre-development loads can be calculated based on either actual pre-development land cover conditions (for redevelopment) or an assumed loading rate for undeveloped land (for new development).
5. Technology-Based Standard: This is a simplified compliance method whereby allowable BMPs are listed along with applicable conditions and design standards. The current Virginia regulations allow a technology approach. Various BMPs are listed along with their assumed removal rates and the range of applicable impervious cover conditions.
6. Blended Standard: Many programs use a blend of the methods listed above. For instance, some programs may use the No Net Increase approach for new development and a 10% reduction of pre-development loads for redevelopment. Some state programs use a Pollutant Load Performance Standard only for sensitive receiving waters.

Section 5 provides profile sheets with more detail on each of these methods.

4. Evaluating an Appropriate Method for Virginia's Stormwater Program

It is important to evaluate the methods based on criteria unique to Virginia's stormwater management program in order to select the most appropriate methods. The following evaluation criteria can be used for this purpose.

- Tributary Strategy Goals: Can the method support meeting Virginia's Tributary Strategy goals for urban land.

- Non-Bay Tributary Goals: Can the method support pollutant reduction goals established for non-Bay tributaries as part of watershed plans.
- Reasonability Test: Does the method lead to site-based requirements that can reasonably be met with the current suite of structural and non-structural BMPs.
- Ease of Use: Will the method be easily understood by both site designers and plan reviewers in a way that reduces unnecessary conflict about computation procedures.
- Infill & Redevelopment: Does the method provide incentives or disincentives for infill and redevelopment that may be encouraged in a local land use plans.
- BSD/LID: Can the method be adapted easily to incorporate and provide incentives for BSD and LID design techniques.
- Integration With Other Stormwater Standards: How easily can the method be streamlined to produce a full-site compliance system that includes channel protection, quantity control, or other standards.

Based on these criteria, we recommend the use and implementation of a blended approach that utilizes aspects of the pollutant load based standard (Method #2) and the technology based standard (Method #5).

5. Profile Sheets for the Various Methods

The following fact sheets provide the following information for each method listed in Section 3:

- Brief background on the method
- Review of the method's use in Virginia and other states
- Examples of the method for four different development scenarios
- Adaptations of the method for BSD/LID
- The main on-the-ground BMP outcomes that result from the method
- The method's chief pros and cons

All computations are based on the Simple Method, with modifications where noted.

Impervious cover assumptions for the four development scenarios are based on Cappiella and Brown, 2001. This study used measurements taken from aerial photos in four suburban communities in the Chesapeake Bay watershed.

PROFILE SHEET: METHOD #1 – CBLAD METHOD

Background

This method was originally developed by the Chesapeake Bay Local Assistance Department (CBLAD) as a compliance method when the Chesapeake Bay Preservation Act and Regulations were first adopted (Chesapeake Bay Local Assistance Manual, Appendix C). At the time, the water quality requirement was only mandatory for communities in the Tidewater area.

When the Virginia Stormwater Management Act and Regulations were adopted in 2001, it became necessary to reconcile the CBLAD approach with the method outlined in the new Stormwater Regulations. At that time, pollutant removal efficiencies were updated and CBLAD and DCR worked together to develop one method that could be used for both programs. The technology-based standard was also introduced with the Virginia Stormwater Management Regulations. With this reconciling of methods, the new method was still only mandatory for Tidewater localities and state agencies. Localities outside of Tidewater could elect to adopt the water quality standard (and the rest of the Stormwater Regulations) at their discretion.

One main facet of the CBLAD/DCR method is the identification of the "average land cover condition." This was set at 0.44 pounds/acre/year, which corresponds to 16% impervious cover (using Virginia's Simple Method assumptions for rainfall – 43 inches/year – and flow-weighted pollutant concentration – 0.26 mg/L).

Use in Virginia & Other States

As noted above, this method was developed for Virginia's Chesapeake Bay Preservation Act compliance system, and later adopted by DCR in the Virginia Stormwater Management Regulations and Handbook. We do not know of other states that use an average land cover condition assumption.

Method #1: CBLAD METHOD – EXAMPLE BMP OUTCOMES	
Development Scenario	**Computation** – Section 5-10, Virginia Stormwater Management Handbook
Example #1: Residential Subdivision, ¼ acre lots, I = 28%	L_{post} - L_{pre} = *0.25 lbs/acre* *BMP Efficiency Required = 36%*
Example #2: Multi-Family, I = 44%	L_{post} - L_{pre} = *0.57 lbs/acre* *BMP Efficiency Required = 57%*
Example #3: Commercial, I = 72%	L_{post} - L_{pre} = *1.15 lbs/acre* *BMP Efficiency Required = 72%*
Example #4: Commercial Redevelopment, existing I = 50%; proposed I = 70%	L_{post} – (L_{pre}*(existing) x 0.9) = 0.52 lbs/acre* *BMP Efficiency Required = 34%*
BSD/LID Modifications • The existing method makes is difficult to use BSD/LID since removal efficiencies are only ascribed to the structural practices listed in Table 5-14 of the Handbook. • In general, it is difficult to assign pollutant removal efficiencies to many non-structural, BSD, and LID practices – especially conservation of open space, preservation of natural drainage, soil amendments, etc.	
Summary of BMP Outcomes • Typical residential subdivisions (1/2 acre to ¼ acre lots) have modest pollutant removal requirements. Most can satisfy requirements with extended detention (ED) basins or grass swales. Any development with impervious cover less than 16% can do nothing at all for water quality treatment. • Multi-family and commercial removal requirements necessitate bioretention, enhanced ED, retention basins, sand filters, manufactured BMPs, or, in some cases, BMPs in series (depending on local program interpretations). • Redevelopment removal requirements are reasonable when existing impervious cover exceeds the average land cover condition by a substantial margin. When this is not the case, redevelopment requirements are similar to new development. Therefore, BMP outcomes are variable.	
Pros	**Cons**
• Fairly simple & straight-forward • Redevelopment requirements are achievable if existing impervious cover is relatively high • Used to meet objectives for multiple programs: DCR & CBLAD	• Lower density development has little or no water quality treatment • Average land cover condition no longer supported by more recent monitoring data • Does not support Tributary Strategy goals for urban land • Almost always results in structural BMPs, most often basins

PROFILE SHEET: METHOD #2 – POLLUTANT LOAD PERFORMANCE STANDARD

Background

This is the method proposed by the TAC for revisions to the Virginia Stormwater Management Regulations. In the draft version, numerical performance standards are identified for both total phosphorus (TP = 0.28 lbs/acre) and total nitrogen (TN = 2.68 lbs/acre).

The numerical pollutant load standard is usually used when a target watershed load is known through a study or plan, particularly for sensitive receiving waters. The intent is that new loads associated with development will not exceed the target or pollutant load goal, thus maintaining acceptable water quality conditions in the receiving water. For instance, Virginia's proposed load limits are tied to Tributary Strategy goals for urban land.

Conceivably, this type of approach will become more widespread for watersheds that have a TMDL waste load allocation study and implementation plan.

Use in Virginia & Other States

This method is proposed for Virginia. Examples from other states include:

- Maine, At-Risk Lakes: Maine's Stormwater Regulations have a phosphorus loading standard for development projects that discharge directly to a "lake most at risk." The state designates these at-risk lakes based on the following criteria:
  - Public water supply
  - Violation of water quality standards
  - Current water quality
  - Potential for internal cycling of phosphorus
  - Potential as a cold water fishery
  - Volume and flushing rate
  - Projected growth in the watershed

  The driving force is the occurrence of algal blooms. The Department of Environmental Protection determines a per acre phosphorus limit for each lake in the at-risk category, or the applicant may propose an alternative load limit (State of Maine DEP, 2005).
- North Carolina, Neuse River Basin: The *Neuse River Basin, Nutrient Sensitive Waters Management Strategy* identifies a nitrogen load limit for new development. This limit is specified as "70 percent of the average nitrogen load contributed by the 1995 land uses of the non-urban areas of the Neuse River Basin," which computes to 3.6 pounds/acre/year. In essence, new development is expected to function like non-urban land at the baseline 1995 loading. The program also allows an offset payment for wetland and riparian restoration if full on-site compliance cannot be achieved. However, each site must meet minimum on-site standards of 6 pounds/acre/year for residential and 10 pounds/acre/year for commercial/industrial uses.

METHOD #2: POLLUTANT LOAD STANDARD – EXAMPLES & BMP OUTCOMES	
Development Scenario	**Computation – Based on 0.28 lbs/acre/year for TP & 2.68 lbs/acre/year for TN. Also Virginia EMCs were used (see Appendix A)**
Example #1: Residential Subdivision, ¼ acre lots, I = 28%	*Phosphorus* $L_{post} - L_{standard} = 0.46$ *lbs/acre* *BMP Efficiency Required = 62%* *Nitrogen* $L_{post} - L_{standard} = 4.39$ *lbs/acre* *BMP Efficiency Required = 62%*
Example #2: Multi-Family, I = 44%	*Phosphorus* $L_{post} - L_{standard} = 0.62$ *lbs/acre* *BMP Efficiency Required = 69%* *Nitrogen* $L_{post} - L_{standard} = 1.70$ *lbs/acre* *BMP Efficiency Required = 39%*
Example #3: Commercial, I = 72%	*Phosphorus* $L_{post} - L_{standard} = 1.41$ *lbs/acre* *BMP Efficiency Required = 80%* *Nitrogen* $L_{post} - L_{standard} = 4.18$ *lbs/acre* *BMP Efficiency Required = 61%*
Example #4: Commercial Redevelopment, existing I = 50%; proposed I = 70%	*Phosphorus* $L_{post} - (L_{pre(existing)} \times 0.56) = 0.81$ *lbs/acre** *BMP Efficiency Required = 59%* ** The proposed regulations stipulate a 44% reduction from existing conditions, rather than the 0.28 load limit.* *Nitrogen* $L_{post} - (L_{pre(existing)} \times 0.72) = 3.14$ *lbs/acre** *BMP Efficiency Required = 47%* ** The proposed regulations stipulate a 28% reduction from existing conditions, rather than the 2.68 load limit.*
BSD/LID Modifications ▪ See Fact Sheet #1 on the CBLAD Method. Similar considerations apply to the pollutant load performance standard method.	

Summary of BMP Outcomes

- This method pushes the removal requirement for typical residential subdivisions (1/2 acre to ¼ acre lots) to 50% or more. This effectively changes the rules of the game for these types of developments, and the types and designs of BMPs would need to be broadened (more bioretention and infiltration). It would also likely provide a strong incentive for the use of BSD/LID credits if they are available.
- Multi-family and commercial removal requirements are pushed to or beyond the top tier of currently available BMPs (as listed in Table 5-14 of the Handbook). These sites would likely use "advanced" BMPs (sand and manufactured filters, enhanced bioretention, enhanced ponds) or a "maximum extent practical" approach.
- For redevelopment, the proposed regulations do not use the load standard, but a 44% reduction from existing loads. If the load standard were applied to redevelopment, commercial sites would have to meet stringent removal rates.

Pros	**Cons**
▪ Raises the bar for BMP design and performance in Virginia ▪ Allows numerical tracking for Tributary Strategy efforts ▪ Computations are simple and straight-forward ▪ Works well with pro-rata fee concept	▪ Removal rates exceed existing BMP performance capabilities for sites with high impervious cover. This is especially true for P, but also for N. ▪ Increased cost for compliance ▪ If an offset or pro-rata fee is included in the system, administration of such a program is beyond the capability of many local governments at this time.

PROFILE SHEET: METHOD #3 – ACROSS THE BOARD REMOVAL RATE STANDARD

Background

This method is based on a pollutant of concern – most commonly this pollutant is total suspended solids (TSS). Regulations typically require that the average annual TSS be reduced by 80% and Total Phosphorus (TP) by 40%. Annual TSS loadings can be calculated by adding the TSS loadings expected to be generated during an average 1-year period from precipitation events less than or equal to the 2-year/24-hour storm. The 80 percent standard can be achieved by reducing, over the course of the year, 80 percent of these loadings (US EPA, 1993).

The 80% removal goal for TSS is a management measure developed by EPA as part of the Coastal Zone Act Reauthorization Amendments of 1990. It was selected by EPA for the following factors: (1) removal of 80% is assumed to control heavy metals, phosphorus, and other pollutants; (2) a number of states require/recommend TSS removal of 80% or greater for new development; and (3) data show that certain structural controls, when properly designed and maintained, can meet this performance level. Further discussion of water quality standards for stormwater management measures can be found in the CZARA Coastal Zone 6217(g) management measures document entitled "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters" (US EPA, 1993).

Since the time of the CZARA regulations, more data has become available on actual BMP performance (see **Appendix C**).

Use in Virginia & Other States

- Delaware, Florida, Wisconsin, and the Lower Colorado River Authority (Texas) require and have implemented a TSS removal treatment standard of at least 80 percent for new development.
- Wisconsin requires 40% TSS removal for redevelopment areas
- Maryland Critical Areas – this criteria specifies that any development within the Intensely Developed Areas must reduce total phosphorus loads from a development site to a level at least 10% below the load generated by the same site prior to development.

METHOD #3: ACROSS THE BOARD – EXAMPLES & BMP OUTCOMES	
Development Scenario	**Computation –** 80% TSS Removal (used national EMCs) 40% TP Removal (used new VA TP EMCs)
Example #1: Residential Subdivision, ¼ acre lots, I = 28%	*Phosphorus* L_{post}= *0.74 lbs/acre* *BMP Efficiency Required = 40%* *Pollutant Removal Requirement = 0.30 lbs/year* *Total Suspended Solids* L_{post}= *164.25 lbs/acre* *BMP Efficiency Required = 80%* *Pollutant Removal Requirement = 131.40 lbs/year*
Example #2: Multi-Family, I = 44%	*Phosphorus* L_{post} *=0.9 lbs/acre* *BMP Efficiency Required = 40%* *Pollutant Removal Requirement = 0.36 lbs/year* *Total Suspended Solids* L_{post}= *242.56 lbs/acre* *BMP Efficiency Required = 80%* *Pollutant Removal Requirement = 194.05 lbs/year*
Example #3: Commercial, I = 72%	*Phosphorus* L_{post} *= 1.41 lbs/acre* *BMP Efficiency Required = 40%* *Pollutant Removal Requirement = 0.56 lbs/year* *Total Suspended Solids* L_{post}= *379.62 lbs/acre* *BMP Efficiency Required = 80%* *Pollutant Removal Requirement = 303.69 lbs/year*
Example #4: Commercial Redevelopment, existing I = 50%; proposed I = 70%	*Total Suspended Solids* L_{post}= *369.83 lbs/acre* *BMP Efficiency Required = 40%* *Pollutant Removal Requirement = 147.93 lbs/year*
BSD/LID Modifications • Easy to incorporate credits into this method • Using BSD/LID to subtract drainage area or surface area from (I) – this is a strong incentive to utilize these types of credits as it reduces overall requirement	

Summary of BMP Outcomes

- % Removal requirement the same across all types of developments
- In comparison with other methods, this method requires a much smaller amount of TP (lbs/year) removed for multi-family and commercial developments

Pros	Cons
• Simple & straight-forward • Not too prescriptive – allows developers to choose from menu of BMPs which meet pollutant removal efficiency requirements (i.e., BMPs that are capable of removing 80% TSS) • Credits easily incorporated	• Assumes BMPs will achieve median removal efficiency regardless of design, construction, maintenance, site conditions and EMC. • Depends on removal efficiencies where data maybe sparse or highly variable, especially for newer or innovative technologies. • Assumes TSS is good indicator for other pollutants in stormwater runoff

PROFILE SHEET: METHOD #4 – NO NET INCREASE LOAD STANDARD

Background

Through this standard, communities require applicants to prepare pollutant loading calculations that are intended to keep pollutant levels to the pre-developed condition baseline - new development cannot exceed the pre-developed load based on pre-developed land cover conditions. The net difference between these two loads must be reduced through stormwater treatment practices.

Use in Virginia & Other States

- No net increase of pollutant load from stormwater runoff is often stated as a desired outcome or goal but is not commonly embedded in regulations, criteria or standards. Many communities do require that post-development peak discharge equals pre-development peak discharge. No net increase of pollutants is a commonly stated as a goal of TMDLs and water quality trading programs.
- Albemarle County, VA requires that BMPs be designed to remove the difference between post development and pre-development total phosphorus loads in cases where post-development loads exceed pre-development loads.
- Towns of Duxbury, Marshfield, & Plymouth, MA require that the post-development load be equal to or less than the pre-developed load for subdivisions 30 lots or more, and any commercial project with a building 10,000 square feet or more.
- City of Dripping Springs, TX does explicitly calls out no net increase of pollutant loads in their Water Quality Protection Ordinance

METHOD #4: No Net Increase – EXAMPLES & BMP OUTCOMES	
Development Scenario	**Computation –** Used VA Low Impervious and High Impervious EMCs
Example #1: Residential Subdivision, ¼ acre lots, existing (pre) I = 1.9%; proposed I = 28%	*Phosphorus* L_{post} - L_{pre} = *0.58 lbs/acre* *BMP Efficiency Required = 78%* *Nitrogen* L_{post} - L_{pre} = *5.50 lbs/acre* *BMP Efficiency Required = 78%*
Example #2: Multi-Family, existing (pre) I = 1.9%; proposed I = 44%	*Phosphorus* L_{post} - L_{pre} = *0.76 lbs/acre* *BMP Efficiency Required = 85%* *Nitrogen* L_{post} - L_{pre} = *3.72 lbs/acre* *BMP Efficiency Required = 85%*
Example #3: Commercial, existing (pre) I = 1.9%; proposed I = 72%	*Phosphorus* L_{post} - L_{pre} = *1.27 lbs/acre* *BMP Efficiency Required = 90%* *Nitrogen* L_{post} - L_{pre} = *6.20 lbs/acre* *BMP Efficiency Required = 90%*
Example #4: Commercial Redevelopment, existing I = 50%; proposed I = 70%	*Phosphorus* L_{post} - L_{pre} = *0.36 lbs/acre* *BMP Efficiency Required = 26%* *Nitrogen* L_{post} - L_{pre} = *1.77 lbs/acre* *BMP Efficiency Required = 26%*
BSD/LID Modifications • Easy to incorporate credits into this method • Using BSD/LID to subtract drainage area or surface area from (I) – this is a strong incentive to utilize these types of credits as it reduces overall requirement	
Summary of BMP Outcomes • Efficiency requirements are the highest of any method. Requirements for commercial (high impervious) sites exceed the current limits of BMP performance, especially if infiltration is not an option.	
Pros	**Cons**
• Strong conceptual underpinning – no increase in pollutants • Not too prescriptive – allows developers to choose from menu of BMPs which meet pollutant removal efficiency requirements • Credits can be incorporated	• Not commonly used for water quality requirements • May be very difficult to achieve at higher impervious cover levels • Requires more complicated calculation review for both pre and post development loads.

PROFILE SHEET: METHOD #5 – TECHNOLOGY BASED STANDARD

Background

The technology based standard matches land use types and characteristics and/or ranges of impervious cover with applicable BMPs. It is a simplified method that eliminates the need for load computations and the matching of presumed BMP performance with on-site pollutant removal requirements.

The technology method allows a program to focus on BMP selection and minimum design elements. However, the method does not allow for an accounting of pollutants at the site or watershed level.

Use in Virginia & Other States

Virginia Regulations: The existing Stormwater Management Regulations contain technology-based criteria (4 VAC 3-20-71.C). The criteria list several types of BMPs, impervious cover ranges, and phosphorus removal targets. The section also allows "innovative or alternate" BMPs at the discretion of the local program administrator. To achieve the listed removal efficiencies, BMPs are to be designed according to specific design standards, understood to be the Virginia Stormwater Management Handbook.

This section of the Virginia regulations provides a foundation for a technology approach, but has a couple of shortcomings:

- BSD/LID approaches would have to be allowed by the local program, and few local programs are willing to go out on a limb to assign pollutant removal efficiencies without guidance and support from the State.
- While the section provides reference to the design standards in the Handbook, the Handbook is not set up to discern design elements that are required or just recommended. Therefore, there is little control over actual designs that meet the technology standard.

James City County, VA: As a local example in Virginia, James City County's "BMP Point System" and "Special Stormwater Criteria" both assign points or compliance units to a range of practices. The Point System, which applies to most sites in the County, includes points for open space conservation easements. The Special Stormwater Criteria, which apply only to selected high-priority watersheds, assigns units to a wide range of BSD/LID approaches, as well as structural practices.

Other State & Local Programs: The use of technology tables is an area of unique creativity within the stormwater world. While the technology approach does not seem to be widespread, there are examples where a technology table is embedded into a compliance system. The *Draft Pennsylvania Stormwater Best Management Practices Manual* uses a technology approach for water quality compliance for some sites (Chapter 8, Worksheets 10 and 11 – Water Quality Compliance for Nitrate). Of

particular interest, both non-structural (BSD) and structural techniques are included in the table.

The Kansas City Mid-America Regional Council's *Manual of Best Management Practices for Stormwater Quality* uses a unique level of service approach. Various non-structural and structural practices are assigned points (water quality treatment rating) towards overall compliance. In this regard, it has some similarities to the James City County system.

The appropriate links for both the Pennsylvania and Kansas City manuals are below.

- http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/stormwatermanagement/BMP%20Manual/BMP%20Manual.htm
- http://www.kcapwa.net/docs/specs/APWA5600BMP.pdf

METHOD #5: TECHNOLOGY BASED STANDARD – EXAMPLES & BMP OUTCOMES	
Development Scenario	**Computation/BMP Selection – *Virginia Stormwater Management Regulations, 4VAC3-20-71.C***
Example #1: Residential Subdivision, ¼ acre lots, I = 28%	*Available BMPs: constructed wetland, extended detention, retention* *Target P Removal: 30 – 40%*
Example #2: Multi-Family, I = 44%	*Available BMPs: bioretention, enhanced extended detention, retention, infiltration* *Target P Removal: 50%*
Example #3: Commercial, I = 72%	*Available BMPs: sand filter, infiltration, enhanced retention* *Target P Removal: 65%*
Example #4: Commercial Redevelopment, existing I = 50%; proposed I = 70%	*See above*

BSD/LID Modifications

- The existing Virginia technology-based system would make it difficult to get credit for BSD/LID, since these approaches are not listed in the table. It can be difficult to assign presumed removal efficiencies to these measures.
- Several local programs in Virginia do allow for open space and some BSD through technology type approaches. For instance, James City County includes open space conservation in its "BMP Point System" (each site must obtain 10 points based on BMPs selected from a table). In addition, the County's Special Stormwater Criteria include a wide range of BSD approaches. Therefore, it is possible to build BSD/LID into a technology approach.

Summary of BMP Outcomes

- Simply put, BMP are selected from the technology table. The power of omission is at work – if a BMP is not listed, it will likely not be selected. Depending on the BMP, this can be good or bad.

Pros	**Cons**
▪ Generally easy to understand and use for design consultants and plan reviewers ▪ Every site must do something – there is no "break point" unless this is part of the system ▪ Reduces haggling about water quality computations and arguments about BMPs in series ▪ Refocuses emphasis to BMP design ▪ With proper structure, can incorporate BSD/LID	▪ Cannot be used to generate loading numbers for a site or watershed ▪ Relies heavily on proper design guidance and good design, construction, and maintenance

Section 6. Summary

Figure 1 illustrates the total phosphorous removal requirement for the five methods summarized in this appendix. The figure shows that Method 1 (CBLAD) results in modest pollutant removal requirements for typical residential sites, but becomes more stringent as impervious cover increases. Method 2 (performance standard) results in higher required removal rates for all land use categories. Method 3 (across the board rate) is the same regardless of land use (i.e;, always 40%). Method 4 (no net increase) is the most stringent, especially when undeveloped sites are converted to high impervious cover sites. Method 5 (technology based) assumes that numerical standards will be met with appropriate BMP selection and design. It should be noted that most BMPs top out at approximately 65% removal efficiency, although sites that can use infiltration can achieve higher rates.

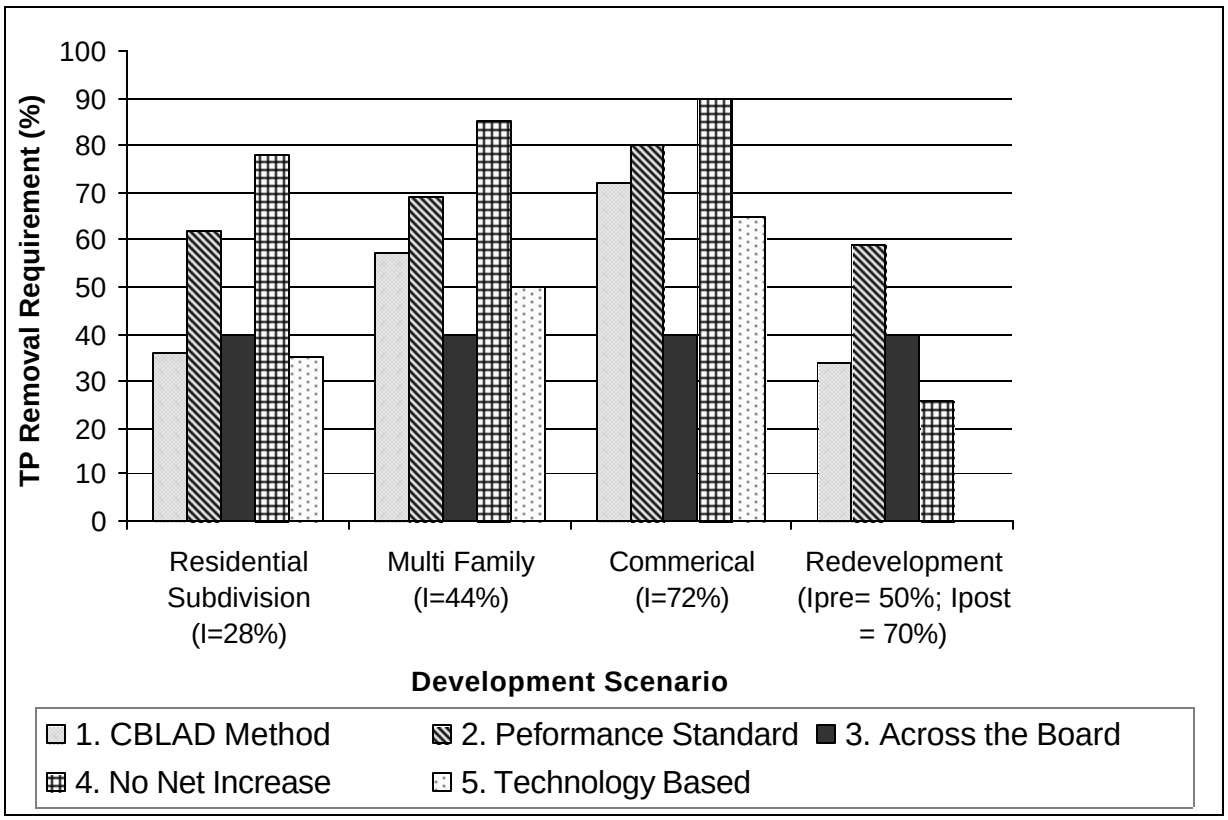

Figure 1. Total Phosphorus Removal Requirement (%) by Method

Based on the information provided within this appendix, a blended approach that utilizes aspects of the pollutant load based standard (Method #2) and the technology based standard (Method #5) is recommended for the Nutrient Design System.

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